**WHAT IS CLAIMED IS:**

1. A failure analysis method using an original fail bit map that is prepared, based on the data about the position of a failure memory cell having inferior electrical characteristic in a plurality of memory cells arranged in matrix form, by associating said failure memory cell with a fail bit in bit units, and mapping to the arrangement of said memory cells,

said failure analysis method comprising the steps of:

(a) preparing various compressed fail bit maps from said original fail bit map; and

(b) calculating fail rates of said respective compressed fail bit maps and distinguishing a fail shape based on said fail rates,

said compressed fail bit maps being prepared by the following steps: dividing said original fail bit map based on each of a plurality of compression areas having different size to convert into various forms in each of which a plurality of pixels of equal size to said their respective compression areas are arranged; and regarding said pixels containing said fail bit, as a fail pixel, and

said fail rates being defined by the ratio of said fail pixel in a predetermined region.

2. The failure analysis method according to claim 1 wherein said step (b) includes the steps of:

(b-1) by using as a reference fail rate said fail rate about one of said compressed fail bit maps, estimating a fail shape at least by collating a predetermined fail rate for distinguishing a fail shape with said reference fail rate;

(b-2) obtaining index values for fail shape judgement by standardizing said fail rates of the rest of said compressed fail bit maps by using said reference fail rate as a denominator; and

(b-3) collating said index values with a predetermined fail shape judgement rule

5   to obtain a result, and distinguishing a fail shape based on said result and the result of the fail shape estimation in said step (b-1).


3.   The failure analysis method according to claim 2 wherein,

said step (b) includes the step of judging whether said fail pixel in said

10   predetermined region is adjacent to said fail pixel in a region other than said predetermined region, and

said step (b-1) performs a fail shape estimation based on the result of the collation between said predetermined fail rate and said reference fail rate, and the result of said judging step.

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4.   A failure analysis method using an original fail bit map that is prepared, based on the data about the position of a failure memory cell having inferior electrical characteristic in a plurality of memory cells arranged in matrix form, by associating said failure memory cell with a fail bit in bit units, and mapping to the arrangement of said

20   memory cells,

said failure analysis method comprising the steps of:

(a) preparing various compressed fail bit maps from said original fail bit map; and

(b) calculating fail rates of said respective compressed fail bit maps and

25   distinguishing a fail shape based on said fail rates,

said compressed fail bit maps being prepared by the following steps: dividing said original fail bit map based on a predetermined compression area to convert into such a form that a plurality of pixels of equal size to said compression area; judging based on each of a plurality of compression thresholds defining the number of said fail bits in said pixels whether said pixels are fail, and regarding said pixels containing a number of said fail bits corresponding to their respective compression thresholds, as a fail pixel, and

said fail rates being defined by the ratio of said fail pixel in a predetermined region.

5. The failure analysis method according to claim 4 wherein said step (b) includes the steps of:

(b-1) by using as a reference fail rate said fail rate about one of said compressed fail bit maps, estimating a fail shape by collating at least a predetermined fail rate for distinguishing a fail shape with said reference fail rate;

(b-2) obtaining index values for fail shape judgement by standardizing said fail rates of the rest of said compressed fail bit maps by using said reference fail rate as a denominator; and

(b-3) collating said index values with a predetermined fail shape judgement rule to obtain a result, and distinguishing a fail shape based on said result and the result of the fail shape estimation in said step (b-1).

6. The failure analysis method according to claim 5 wherein,

said step (b) includes the step of judging whether said fail pixel in said predetermined region is adjacent to said fail pixel in a region other than said predetermined region, and

said step (b-1) performs a fail shape estimation based on the result of the collation between said predetermined fail rate and said reference fail rate, and the result of said judging step.

5          7.    A failure analysis method using an original fail bit map that is prepared, based on the data about the position of a failure memory cell having inferior electrical characteristic in a plurality of memory cells arranged in matrix form, by associating said failure memory cell with a fail bit in bit units, and mapping to the arrangement of said memory cells,

10          said failure analysis method comprising the steps of:

          (a) preparing various compressed fail bit maps from said original fail bit map; and

          (b) calculating fail rates of said respective compressed fail bit maps and distinguishing a fail shape based on said fail rates,

15          said compressed fail bit maps being prepared by the following steps: dividing said original fail bit map based on each of a plurality of compression areas having different size to convert into various forms in each of which a plurality of pixels of equal size to said their respective compression areas arranged; based on each of a plurality of compression thresholds defining the number of said fail bits in said pixel whether said

20    pixels are fail, and regarding said pixels containing not less than a number of said fail bits corresponding to their respective compression thresholds, as a fail pixel, and

          said fail rates being defined by the ratio of said fail pixel in a predetermined region.

25          8.    The failure analysis method according to claim 7 wherein said step (b)

includes the steps of:

(b-1) by using as a reference fail rate said fail rate about one of said compressed fail bit maps, estimating a fail shape by collating at least a preset predetermined fail rate for distinguishing a fail shape with said reference fail rate;

5      (b-2) obtaining index values for fail shape judgement by standardizing said fail rates of the rest of said compressed fail bit maps by using said reference fail rate as a denominator; and

(b-3) collating said index values with a predetermined fail shape judgement rule to obtain a result, and distinguishing a fail shape based on said result and the result of the

10     fail shape estimation in said step (b-1).


9.     The failure analysis method according to claim 8 wherein,

said step (b) includes the step of judging whether said fail pixel in said predetermined region is adjacent to said fail pixel in a region other than said

15     predetermined region, and

said step (b-1) performs a fail shape estimation based on the result of the collation between said predetermined fail rate and said reference fail rate, and the result of said judging step.


20     10.    A computer readable recording medium for recording a program that allows a computer to execute a failure analysis method according to claim 1.


11.    A computer readable recording medium for recording a program that allows a computer to execute a failure analysis method according to claim 4.

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12. A computer readable recording medium for recording a program that allows a computer to execute a failure analysis method according to claim 7.

13. A method of deriving a compression threshold used in a failure analysis

5    method using an original fail bit map that is prepared, based on the data about the position of a failure memory cell having inferior electrical characteristic in a plurality of memory cells arranged in matrix form, by converting said failure memory cell with a fail bit in bit units, and mapping to the arrangement of said memory cells,

said method of deriving a compression threshold comprising the steps of:

10   (a) dividing said original fail bit map based on a predetermined compression area, and converting into such a form that a plurality of pixels of equal size to said compression area are arranged;

(b) counting, per said pixel, said fail bits in said pixels; and

(c) obtaining characteristic of existence of said fail bits that is expressed by the

15   number of said pixels to the number of said fail bits in said pixels and, based on said characteristic of existence, thereby to calculate said compression thresholds.

14. The method of deriving compression thresholds according to claim 13 wherein said step (c) includes the step of taking count of pixels starting when the number

20   of said fail bits is 1, and adopting, as a compression threshold, the number of said fail bits when the number of said pixels first reaches a minimum value.

15. A computer readable recording medium for recording a program that allows a computer to execute a method of deriving compression thresholds according to

25   claim 13.

16. A failure analysis method using an original fail bit map that is prepared, based on the data about the position of a failure memory cell having inferior electrical characteristic in a plurality of memory cells arranged in matrix form, by associating said

5    failure memory cell with a fail bit in bit units, and mapping to the arrangement of said memory cells,

said failure analysis method comprising the steps of:

(a) preparing compressed fail bit maps from said original fail bit map; and

(b) extracting said fail bits in a predetermined region in said compressed fail bit

10   map as fail bits of the same group,

said compressed fail bit map being prepared by the following steps of: dividing said original fail bit map based on each of a plurality of compression areas each having a predetermined size to convert into a form in which a plurality of pixels of equal size to their compression areas are arranged; judging based on each of a plurality of compression

15   thresholds defining the number of said fail bits in said pixels whether said pixels are fail, and regarding said pixels containing not less than a number of said fail bits corresponding to their respective compression thresholds, as a fail pixel, and

said step (a) includes the step of compressing said original fail bit map by using said compression threshold,

20      said predetermined region being defined by predetermined number of said pixels, and

said step (b) includes the step of judging said fail pixels in said predetermined number of pixels as pixels in the same group, and extracting said fail bits included in the group as bits in the same group.

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17. The failure analysis method according to claim 16 further comprising the step of, after said step (b),

(c) preparing a processed original fail bit map by eliminating said fail bits extracted as said same group from said original fail bit map,

wherein said steps (a) to (c) are repeated predetermined number of times to extract said fail bits of other group, and

in the second and subsequent times, said step (a) prepares said compressed fail bit map based on said processed original fail bit map in place of said original fail bit map.

18. The failure analysis method according to claim 17, further comprising the step of displaying only said fail bit in said same group on a fail bit map.

19. The failure analysis method according to claim 17, further comprising the step of simultaneously displaying said fail bit in said same group and said fail bit in said other group in different display colors on a fail bit map.

20. The failure analysis method according to claim 17, wherein said failure analysis method is conducted on a plurality of wafers, and further comprises the step of dividing each of said plurality of wafers into a plurality of concentrical annular-shaped areas by using a wafer center portion as a center area and counting the number of said fail bits in said same group and that of said fail bits in said other group in each of said plurality of concentrical annular-shaped areas in each of said plurality of wafers.

21. The failure analysis method according to claim 17, wherein said failure analysis method is conducted on a plurality of wafers, and further comprises the step of

radially dividing each of said plurality of wafers into a plurality of areas every predetermined angle by using a wafer center portion as a center and counting the number of said fail bits in said same group and that of said fail bits in said other group in each of said plurality of radial areas.

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22. A computer readable recording medium for recording a program that allows a computer to execute a failure analysis method according to claim 16.

23. The failure analysis method according to claim 17, further comprising the
10 step of

(c) checking an involvement relation between said fail bit included in said same group and said fail bit in said other group after repeating said steps (a) and (b) predetermined number of times,

wherein said step (c) includes the step of defining an involving group and an
15 involved group by comparing coordinates of areas of forming said fail pixels constructing the groups in said compressed fail bit map.

24. The failure analysis method according to claim 23, further comprising the step of displaying only said fail bits in said same group on a fail bit map.

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25. The failure analysis method according to claim 23, further comprising the step of simultaneously displaying said fail bits in said same group and said fail bits in said other group in different display colors on a fail bit map.

25 26. The failure analysis method according to claim 23, wherein said failure

analysis method is conducted on a plurality of wafers, and further comprises the step of dividing each of said plurality of wafers into a plurality of concentrical annular-shaped areas by using a wafer center portion as a center area and counting the number of said fail bits in said same group and that of said fail bits in said other group existing in each of

5    said plurality of concentrical annular-shaped areas of each of said plurality of wafers.

27.    The failure analysis method according to claim 23, wherein said failure analysis method is conducted on a plurality of wafers, and further comprises the step of radially dividing each of said plurality of wafers into a plurality of areas every

10    predetermined angle by using a wafer center portion as a center and counting the number of said fail bits in said same group and that of said fail bits in said other group in each of said plurality of radial areas in each of said plurality of wafers.

28.    A computer readable recording medium for recording a program that

15    allows a computer to execute a failure analysis method according to claim 23.

29.    A failure analysis method using an original fail bit map that is prepared, based on the data about the position of a failure memory cell having inferior electrical characteristic in a plurality of memory cells arranged in matrix form, by associating a

20    failure memory cell with a fail bit in bit units and mapping to the arrangement of said memory cells,

said failure analysis method comprising the steps of:

(a) preparing a compressed fail bit map from said original fail bit map;

(b) preparing a repeatedly compressed fail bit map by further compressing said

25    compressed fail bit map predetermined number of times; and

(c) extracting said fail bits within a predetermined region in said repeatedly compressed fail bit map as fail bits of the same group,

said compressed fail bit maps being prepared by the following steps: dividing said original fail bit map based on a first compression area each having a predetermined

5    size to convert into a form in which the first pixel of equal size to said first compression area are arranged; judging based on the first compression threshold defining the number of said fail bits in said first pixel whether said first pixel is fail, and regarding said first pixel containing not less than a number of said fail bits corresponding to said first compression thresholds, as a first fail pixel, and

10    said repeatedly compressed fail bit maps being prepared by the following steps: dividing said compression fail bit map based on a second compression area having a predetermined size; to convert into a form in which the second pixel of equal size to said second compression area are arranged; judging based on the second compression threshold defining the number of said first fail pixels in said second pixel whether said

15    second pixel is fail, and regarding said second pixels containing not less than a number of said first fail pixels corresponding to said second compression thresholds, as a second fail pixel, and

said step (a) includes the step of compressing said original fail bit map by using said first compression area and said first compression threshold,

20    said step (b) includes the step of compressing said compressed fail bit map by using said second compression area and said second compression threshold,

said predetermined region being defined by the predetermined number of said second pixels, and

said step (c) includes the step of judging said second fail pixels existing within

25    said predetermined number of pixels as pixels in the same group, and extracting said fail

bits included in the group as bits in the same group.

30.   The failure analysis method according to claim 29, further comprising the step of

5   (d) checking an involvement relation between said fail bit included in said same group and said fail bit in said other group after repeating said steps (a) to (c) preset number of times,

wherein said step (d) includes the step of defining an involving group and an involved group by comparing coordinates of areas of forming said second fail pixels

10   constructing each of the groups in said repeatedly compressed fail bit map.

31.   The failure analysis method according to claim 29, further comprising the step of displaying only said fail bits in said same group on a fail bit map.

15   32.   The failure analysis method according to claim 29, further comprising the step of simultaneously displaying said fail bits in said same group and said fail bits in said other group in different display colors on a fail bit map.

33.   The failure analysis method according to claim 29, wherein said failure

20   analysis method is conducted on a plurality of wafers, and further comprises the step of dividing each of said plurality of wafers into a plurality of concentrical annular-shaped areas by using a wafer center portion as a center area and counting the number of said fail bits in said same group and that of said fail bits in said other group existing in each of said plurality of concentrical annular-shaped areas of each of said plurality of wafers.

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34.  The failure analysis method according to claim 29, wherein said failure analysis method is conducted on a plurality of wafers, and further comprises the step of radially dividing each of said plurality of wafers into a plurality of areas every predetermined angle by using a wafer center portion as a center and counting the number of said fail bits in said same group and that of said fail bits in said other group existing in each of said plurality of radial areas in each of said plurality of wafers.

35.  A computer readable recording medium for recording a program that allows a computer to execute a failure analysis method according to claim 29.